THE S. W. SHATTUCK CHEMICAL COMPANY, INC. HAER No. CO-71
1805 South Bannock Street
Denver
Denver County
Colorado

HAER
COLO
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65-

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
Department of the Interior
Rocky Mountain Regional Office
P.O. Box 25287
Denver, Colorado 80225

Historic American Engineering Record
The S. W. Shattuck Chemical Company

Part I. Introduction

Location:	The S. W. Shattuck Chemical Company, Inc. is located at 1805 South Bannock Street in the City and County of Denver, Colorado (Shattuck site). The Shattuck site is located approximately 4 miles south of Denver's downtown area near the intersection of Evans Avenue and Broadway. The property covers approximately 6 acres and is elongated in a north-south direction. It is bordered on the east by South Bannock Street, on the south by West Jewell Avenue, on the west by main-line railroad tracks of the Atchison, Topeka and Santa Fe Railroad and the Denver & Rio Grande Western Railroad, and on the north by a concrete batch plant.
Quadrangle:	U. S. Geological Survey, Englewood 7.5-minute topographic quadrangle, dated 1965, photorevised 1980.
UTMs:	A: 13:500,880 E, 4392435 N B: 13:500,820 E, 4392400 N
Dates of Construction:	The earliest portion of a building still present on the site was constructed in 1911. Other buildings were constructed at later dates, as noted in the individual descriptions herein.
Present Owner:	The S. W. Shattuck Chemical Company, Inc. 1805 South Bannock Street Denver, Colorado 80223
Present Use:	Mineral processing operations at the Shattuck site ceased in April of 1984 due to poor economic conditions associated with molybdenum and rhenium metals. The site is currently undergoing environmental remediation in accordance with the terms of a Superfund Record of Decision issued by the U.S. Environmental Protection Agency ("EPA") on January 28, 1992.
Significance:	The significance of the Shattuck site arises from its role in processing various metals since 1918. At various periods of time, molybdenum compounds, radium, uranium compounds, and rhenium were produced at the site. From about 1934 to the early 1940s, Shattuck was one of only two companies in the U.S. that produced radium salts; although, collectively

both companies produced only a small percentage of the radium used in the U.S. during that period.

Project Statement:

This project was undertaken at the request of EPA as part of the Superfund remediation requirements imposed on the site under CERCLA. Currently, Shattuck does not anticipate resuming any operational activities at the site and it is anticipated that all buildings and facilities will be demolished as part of the remedial action. All of the buildings on the site were vacated when major operations ceased in April of 1984 with the exception of Building No. 3 which remained occupied for administrative and limited chemical processing activities until June of 1986. From June of 1986 until November of 1992 Building No. 3 was the only building occupied and was used solely for administrative purposes. In November of 1992 Buildings No. 1, 3 and 4 were demolished as part of the Superfund remedial action. Buildings No. 2, 5 and 6 and any remaining structures will be demolished in mid 1993.

Prepared By:

Historic Narrative: Steven F. Mehls, Project Historian, Western Historical Studies, Inc. June 1993

Architectural and Historical Engineering Processes Information: Nanon A. Anderson, AIA, Andrews & Anderson, July and October 1992.

Photography: Arnold Thallheimer, April and May 1992.

Part II. Historical Information

The S. W. Shattuck Chemical Company plant on South Bannock Street in Denver stands as an example of the changing nature of Colorado's mineral processing industry during the twentieth century. Over more than six decades (1918-1984) that the plant processed minerals, the types and markets for the finished compounds produced in Colorado changed dramatically. For example, throughout most of its active life the Shattuck plant's operators produced a variety of highly specialized mineral products, often for comparatively narrow markets.[1] Beyond that, Shattuck's specialized operation tended to reflect two important trends in the twentieth century Colorado mineral processing industry. The first was diversification of the industry into a wider area than precious metal processing (primarily gold and silver) and steel making, mainstays of Colorado's industry during the late nineteenth century. Secondly, local processing activity spread from its traditional areas such as Globeville in the northeast part of the city to other parts of Denver. Part of that spread of industrial activity reflected the general growth of Denver during the 1890s and early 1900s.

During the 1880s and especially the 1890s Denver grew along the major rail routes to and from the city. Much of this growth focused on the rail corridor south of the downtown area. Industrial and residential growth followed the expansion of public transit lines that reached south of downtown along Broadway Avenue about four miles by 1892. The presence of public transportation coupled with the Denver and Rio Grande and the Atchison, Topeka and Santa Fe railroad lines south of the old downtown core led to the spread of an industrial and commercial zone from Broadway Avenue west to the railroad tracks by 1900.[2] It was in this area and era that the first developments on the future Shattuck plant site took place.

The site consists of Blocks A (southern portion) and B (northern portion) of the Overland Park Subdivision. The 1893 Sanborn map of the site shows a small building and fenced area in the southwest part of Block B and attributed it to the Parkdale Kaolin Company. It also shows three developed areas in portions of Block A. These developed areas in Block A were reportedly occupied by the Woeber Bros. Carriage Company. The structures in these areas are identified as part of a "Car Shop" and included a wood shop, paint shop, blacksmith and machine shop, engine and boiler rooms, a mill and a storage shed for old street cars. There is a note on the Sanborn map that states the "Old Works Burned Feb., 1893".[3]

A warranty deed transfer for Block B was recorded in March 1899.[4] The deed grantor was The Denver Consolidated Tramway Company and the grantee was the Denver City Tramway Company. The Sanborn map for 1903 does not show any structures in Block B. In Block A, the three developed areas are still evident but they are identified differently. Specifically, the wood shop and paint shop are identified as the "Car Shop - Car Building and Painting, All Hand Work" and the facility is identified as the "Woeber Car Works - Manufactures Street Cars".[5]

In September 1913, a warranty deed for Block A was recorded with the grantor being The Plattner Implement Company and the grantee being Anna Kaub Sigel. The Plattner Implement Company may have moved to the site before they acquired title to it as they built a storage building on the property in 1911.[6] This is the earliest building (HAER No. CO-71-B) on the site that remains extant, although heavily modified. The modifications are attributable to The S. W. Shattuck Company.[7] The Plattner Implement Company was a Colorado corporation incorporated on January 31, 1899 for the purposes of buying, selling, and dealing in all kinds of agricultural implements, wagons and other vehicles, lubricating oils, saddlery and all other articles and things usually handled or sold in connection with agricultural implements. The use of the site as an implement warehouse continued for about seven years through a period of considerable change in the Denver business environment. Block A was transferred in August 1916 to the A. K. Realty and Investment Company.[8] The A. K. Realty and Investment Company's Articles of Incorporation describe the purpose of the corporation as including buying or otherwise acquiring, holding or trading, leasing, dealing in, selling, conveying or otherwise disposing of real estate and personal property of every kind and description.[9]

In March, 1918, The S. W. Shattuck Chemical Company incorporated in Colorado.[10] The purpose of the corporation as stated in its Articles of Incorporation included to purchase, manufacture, and otherwise dispose of chemical products and to mine, purchase, analyze, treat, reduce, concentrate, sell and otherwise dispose of ores and their products. Following the June 1918 death of company founder Sidney W. Shattuck, the company moved from 3311 Walnut Street in Denver to the Bannock Street site. During 1918 The S. W. Shattuck Chemical Company treated molybdenum ores in one end of a building on Bannock Street, while David Taylor processed carnotite ores in the other. Reportedly, no business relationship existed between the two organizations.[11]

On April 1, 1920, the A. K. Realty and Investment Company leased a portion of the site to York Ferro-Alloys Company, a Pennsylvania Corporation.[12] York Ferro-Alloys Company was succeeded by York Metal & Alloys Company, also a Pennsylvania corporation, formed to produce, manufacture, purchase and sell metals and alloys.[13] York Metals & Alloys Company manufactured ferrovanadium and extracted related ores in the La Sal Mountains of Utah.[14] The principal use of ferrovanadium was in steels, especially in tool steels and in situations where steel was subjected to repeated strains. Denver processor, David Taylor (also an officer of York Ferro-Alloys Company), continued treating carnotite ores at the site.[15] In 1922, York Metals & Alloys Company subleased a portion of the site to the York Mining Company, a corporation whose president was David Taylor.[16] The purpose of the corporation was to buy, sell, export, import, and generally deal at wholesale and retail in ores, metals, and minerals of all kinds and to mine, mill, smelt, and treat in anyway whatsoever ores, metals, and minerals of all kinds and descriptions.[17] It is unclear how long David Taylor operated at the site although in 1923, York Mining Company filed a Notice of Dissolution with the Secretary of State.[18] After David Taylor closed his plant and left the area The S. W. Shattuck Chemical Company may have initiated carnotite refining.

In 1924 and 1925, Shattuck made improvements to the site. The title to Block A was transferred again in August 1929 from The A. K. Realty and Investment Company (a successor to Anna Kaub Sigel) to The S. W. Shattuck Chemical Company.[19] At the Shattuck plant the building that housed the Woeber Car Shop is gone, but the early portions of Buildings No. 3 and 4 are shown along with several small outlying structures. No activity was evident in Block B on the 1929 Sanborn map.[20]

In July 1944, Block B of the property was transferred by the Denver City Tramway Company to The S. W. Shattuck Chemical Company.[21] With this transfer, The S. W. Shattuck Chemical Company owned the site in its entirety.

Little is known about the activities at the site during the late 1940s and into the 1950s except that increased molybdenum production may have been the impetus for expansion. The Sanborn map for 1950 shows that the site was occupied by The S. W. Shattuck Chemical Company and that the company was a manufacturer of uranium salts, ammonium molybdic acid, and molybdate.[22] Construction permit records for Building No. 6 (see site plan) show that in October 1955, a warehouse building in that location was demolished and shortly thereafter, a new structure was built with a large stack for the discharge of gases.[23] These facilities were designed and operated to process byproduct molybdenum concentrate to produce technical grade molybdenum oxide, ammonium and sodium molybdates, and high-purity molybdic oxide.

On December 31, 1969 The S. W. Shattuck Chemical Company sold the site and certain assets, including the corporate name, to the present owner, The S. W. Shattuck Chemical Company, Inc. The former owner of the site changed its name to JPL Enterprises, Inc. (JPL Enterprises, Inc. ultimately dissolved in April, 1982).

As much as the industrial and residential growth along transportation corridors south of Denver affected the site's historical development, so did concurrent historical changes in the character of the mineral processing industry.

Locally, the changes in the processing industry reflected the near demise of silver mining and smelting in Colorado following the Panic of 1893 as well as the scientific discoveries being made as the nineteenth century slipped into the twentieth. The earlier Colorado mineral processors depended on gold, silver and in Pueblo, Colorado, steel production for their profits[24]. Twentieth century processors, such as The S. W. Shattuck Chemical Company, refined newly discovered or newly useful minerals to a much greater extent. No longer were huge mills, blast furnaces and other factory-like facilities the only types of processing plants. Smaller and more specialized plants such as Shattuck's were constructed.[25] The materials processed at these plants were equally different and more specialized and included radium, molybdenum, vanadium, uranium, tungsten and rhenium, among others.

Radium, discovered in 1899 by Marie Curie through her work with uranium, became one of the miracle elements of the twentieth century. Radium and its radioactive properties sparked scientific, medical, commercial and military interest during the period 1900 to 1920.[26] By the time of the Curie discovery, the presence of pitchblende, a source of radium and uranium, was already known in Colorado. Certain gold mines in the Central City area of Gilpin County encountered small veins of pitchblende. However, the local miners did not recognize the material and discarded it on the mine waste piles. During 1871 English mining engineer Richard Pearce visited some of the Central City mines for his employer, the Rochdale Mining Co., and found the pitchblende on the waste piles. He collected the material and shipped it to London where it was reduced to uranium oxide to tint glass and ceramics. Sporadically from the 1870s until World War I, Gilpin County mines produced commercial quantities of pitchblende.[27]

Prospectors and miners along the Colorado-Utah border continued their searches for gold and silver, but found sources of radium instead. By 1900 what many of them found was a yellow, powdery mineral in many of the local sandstone formations. The yellow material came to be known as carnotite, an ore rich in uranium and vanadium. The ores found in the area had to be concentrated before shipment to make it economic for production. Mining engineers and scientists expended much energy during the early years of the twentieth century attempting to find economic ways to concentrate the carnotite ores, most with limited success.[28] The difficulty of the refining and the even lower ratio of radium to uranium kept prices for radium high. Process development work to refine carnotite continued into the 1910s. One gram of radium represented the refining of up to 500 tons of carnotite ore. Despite such ratios, the price being paid by the medical profession went to $120,000 per gram.[29] The results were many including a mining boom for carnotite in the Paradox Valley of western Colorado, the founding of companies to process and sell radium, further experimentation with the refining process and the eventual establishment of the National Radium Institute in Denver during 1913 as a quasi-public agency charged with finding a more efficient means to refine the radium. As a result, Denver became the center of the United States radium activity and continued as a leader in the field even after the National Radium Institute closed in 1918.[30]

The United States' role as a leading producer of radium continued until 1922 when large deposits of pitchblende in the Belgian Congo were commercially developed. Those mines gave the Belgians a near monopoly on the world's radium supply into the 1930s and the American radium industry all but disappeared.[31] The failure of the United States' radium industry corresponded with David Taylor and the York Mining Company ceasing operations in Colorado, as mentioned earlier.

The commercial uses for radium in the early twentieth century included medical uses, primarily for cancer treatment, use in patent medicines and use in luminous paints for dials and instrumentation from wrist watches to aircraft gauges. Few people fully understood the nature of radioactivity in those early years and workers, such as the dial painters, were constantly exposed to health risks. By the 1920s the problems were apparent and steps were taken to better understand these risks.[32]

In 1934, The S. W. Shattuck Chemical Company built a frame and transite (corrugated cement and asbestos sheeting) radium plant.[33] <u>Minerals Yearbook, 1935</u>, confirmed that a commercial radium plant was erected on the site in the fall of 1934 and that by the end of that year, the company was ready to start work.[34] The company estimated that production of a gram of radium required the equivalent of 15 men working for a year. It was also stated that the company's past production included dilute radium salts, sodium uranate, uranium nitrate, uranium acetate, and vanadium compounds. Uses of radium salts remained therapeutic, uranium salts continued to be a popular coloring agent for glass and ceramics, and was also used as a steel toughening agent. Vanadium was also commonly used in steel processes.[35] All these products were available in carnotite, the raw material Shattuck used.

The <u>Minerals Yearbook, 1936</u> identified only two companies (one of which was The S. W. Shattuck Chemical Company) receiving carnotite ores or concentrates for extraction of radium for domestic use.[36] A Colorado Bureau of Mines Inspectors' Report dated May 1937 indicates that North Continent Mines, Inc.'s mine and mill in the Klondyke district of southwestern Colorado shipped its product (a radium slime) by truck to Montrose and then by rail to the Shattuck plant in Denver.[37] Operating units of North Continent Mines, Inc., continued to ship processed ores to The S. W. Shattuck Chemical Company in Denver until some time between August 1942 and June 1943.[38]

From 1934 through 1941, The S. W. Shattuck Chemical Company and another out-of-state company participated in a limited American radium production renaissance. During this time period, the primary use of radium remained therapeutic. It became a standard remedy for the removal of birthmarks, the cure of certain tumors, the alleviation or cure for certain cancers, certain cases of leukemia, and other diseases.[39] However, late in the period, radium's use in luminous paints for instrument dials again became an important military application that was employed in airplanes and other military equipment as it had been during World War I. Minerals Yearbook, 1941, reported that about 85 percent of the radium produced in 1940 was for medical uses, 10 percent was for use in luminous paints, and the remaining 5 percent was used for miscellaneous applications such as radiation sources in instruments designed for inspecting metal castings and forgings for inner flaws.[40]

The S. W. Shattuck Chemical Company produced 225 milligrams of radium in 1941 and anticipated an output exceeding 1 gram in 1942.[41] Contrary to that prediction, the Minerals Yearbook, 1942 reported that The S. W. Shattuck Chemical Company devoted its facilities principally to molybdenum compounds and produced no radium.[42] Some uranium and tungsten production was reported at the site during that year. In 1949 radium slimes from processing carnotite ore were sold by The S. W. Shattuck Chemical Company.[43] The sections of the Minerals Yearbook for molybdenum, radium, uranium, and tungsten make no mention of any significant processing at the site between 1942 and 1949. Although the historical record is unclear as to when radium production actually ceased, there is no indication that radium was produced after 1941.

Molybdenum has a history similar to radium in that it is a mineral that became economically important during the first two decades of the twentieth century. Known before 1900 as a mineral useful in the determination of some acids, such as phosphoric acid, and as a pigment for porcelain, the major industrial uses of molybdenum had yet to be determined.[44] Attendant to the rapid rise of the American steel industry during the last quarter of the nineteenth century, the steelmakers learned of the ways that vanadium, tungsten and other metals could significantly strengthen steel and as a result they also experimented with molybdenum. However, it was not until World War I that substantial production of molybdenum steel took place with nearly one million pounds of molybdenum steel produced in the United States during 1918 valued at $1.2 million.[45] The growing market and number of uses for molybdenum during World War I encouraged a host of new companies to explore the business possibilities offered by refining the mineral.

Early molybdenum processing at the Shattuck site started in 1917 (before the company had perfected its incorporation) in response to initial demand for this metal as a steel hardening agent. The record is unclear as to who was responsible for molybdenum production at the site before Shattuck's arrival. Although The S. W. Shattuck Chemical Company was not a primary producer or refiner of molybdenum ores, it did produce specialty molybdenum chemicals in significant quantities which were processed from molybdenum ore. The quantity of molybdenum chemical products produced varied until production was eventually discontinued in the mid 1980s.

In the United States the practice of using molybdenum as a steel hardening agent initiated in earnest in 1918, when a total of 350,000 pounds of molybdenum was produced and/or imported. Nationally, the amount used varied dramatically during the next seven years from as little as 40,000 to as much as 1,000,000 pounds per year. In 1925, significant changes in the manner that molybdenum was added to steel occurred. As a result of this technological advancement, the use of molybdenum in steel production became more accepted and the amounts used steadily increased for a number of years thereafter. Other companies also entered the processing industry by 1920.

Molybdenum, similar to radium, experienced market fluctuations and adjustments during the early 1920s. After World War I ended, molybdenum production essentially ceased for two years. However, by 1923 significant quantities again were coming from mines in the United States. From the mid 1920s, molybdenum production in the U. S. continued to rise until 1941 when the annual domestic usage was in excess of 32,000,000 pounds (another 8,000,000 pounds were exported from the U.S.).[46] The spread of automobiles and airplanes that needed molybdenum hardened steel and the use of molybdenum oxide as a refining catalyst in gasoline production led to increased molybdenum production through the 1930s.[47] In 1939 there was a drop in production, but in the 1940s as the United States began supplying the United Kingdom and others with war materials and President Franklin D. Roosevelt began a rearmament program, American production of molybdenum again spiralled upward. By this time, molybdenum was recognized as an effective replacement for tungsten as a steel-alloying element. Considering the limited resources of tungsten and the need for alloy steels during World War II, the U.S. Government's War Production Board issued a General Preference Order that effectively accelerated the transition from tungsten to molybdenum as an alloying agent in alloy steel production.

During much of the 1950s, molybdenum production in the U.S. continued at record levels ranging from approximately 40,000,000 to 62,000,000 pounds.[48] Undoubtedly, the related demand for molybdenum specialty products was the impetus for the expansions that occurred on the site during that period. Following World War II molybdenum demand climbed until the 1970s, in part because of federal stockpiling of molybdenum as a strategic material until 1972.[49] During the 1970s, American industry, especially users of molybdenum such as car makers and steel makers, began feeling the impact of increasing foreign competition. This was coupled with increased development of foreign molybdenum supplies and traditional large scale molybdenum refiners sought new markets by the end of the decade.[50] Smaller scale producers of molybdenum products, such as Shattuck, were able to sustain a limited market for specialty products. However, market demand for molybdenum continued to decrease and by the mid 1980s it was no longer economical to continue this type of specialty processing.

Uranium, another mineral product of refining carnotite or pitchblende, had a history of limited usage until 1945 and the United States' increased use of uranium for military purposes.[51] Prior to 1945, the primary use of uranium had been as a pigment to color ceramics and glass in oxide form. By 1910 uranium was the almost unwanted by-product of radium refining. In the early 1920s, the demand for uranium salts declined but that trend reversed itself in the mid-1920s through the early 1930s resulting in renewed demand for the yellowish tints that these salts imparted to both glass and ceramics.[52] During that period much of the world's demand was satisfied by the Belgian Congo pitchblende mines. Although there was no significant demand for a domestic source of uranium, the Shattuck plant began to process uranium ores, such as carnotite, during the 1920s.

The 1929 Sanborn map shows that Shattuck manufactured uranium salts, ammonia molybdic acid, and molybdate on the site.[53] The markets Shattuck produced for are not clear, but apparently they were great enough and the prices for the carnotite cheap enough to encourage Shattuck to continue uranium oxide refining.

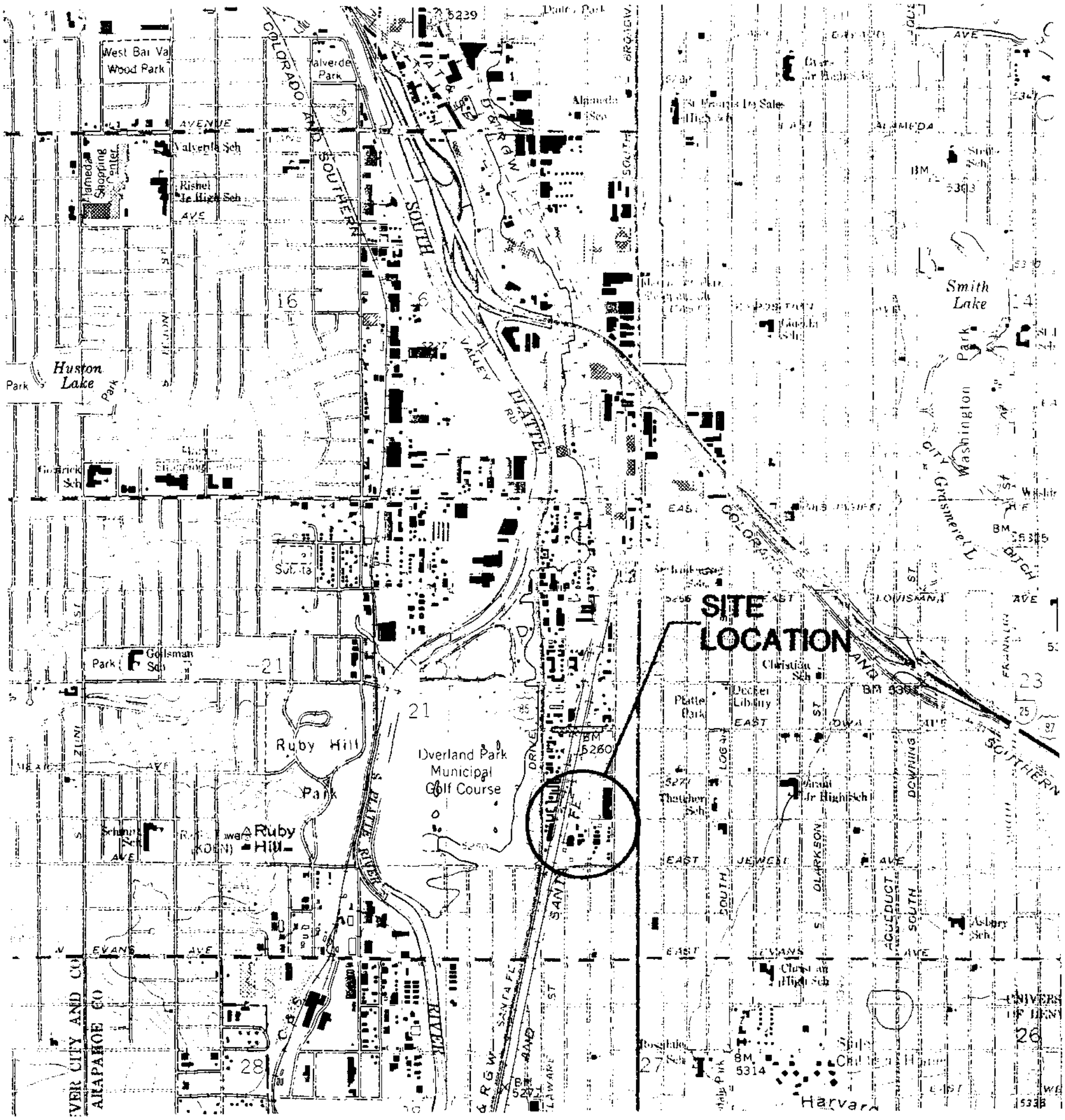
The atomic boom and the presumed omnipotence of nuclear power during the late 1940s led to the fabled uranium or "U-boom" on the Colorado Plateau, as well as spurring increased interest in all the possible uses of uranium as an energy source. Uranium became the world's miracle mineral of the 1940s and 1950s. The Cold War led to an emphasis on increased atomic defense and substantial federal subsidies to defense related industries. The Federal government recognized the immense impacts and potential of uranium and atomic power that led to passage of the Atomic Energy Act in 1946 and subsequent establishment of the Atomic Energy Commission (AEC). The AEC enjoyed broad powers to regulate and control the United States nuclear industry from production of the uranium ore to the licensing of processors, power plants and other uses of nuclear materials.[54]

In 1955 The S. W. Shattuck Chemical Company applied for a radioactive materials license from the Atomic Energy commission and a license was granted effective April of that year.[55] Subsequent source materials licenses stated that natural and depleted uranium were processed in the licensed portion of the site.[56] By the mid to late 1960s environmental concerns and a tremendous domestic stockpile of nuclear weapons ended the uranium boom. These environmental concerns, as well as tighter regulations and decreased demand, all combined to depress the uranium market worldwide. By the late 1970s the supply of uranium began to outstrip demand and uranium prices fell dramatically, resulting in the significant curtailment of uranium production throughout the world. Equally, environmental and safety concerns increased, leading in Denver to the beginning of a massive clean up program for old radium processing sites.[57] The specialty uranium chemical activities at the plant remained viable until 1983 when production ceased. In the early 1980s, the economics of producing uranium compounds was no longer attractive and The S. W. Shattuck Chemical Company, Inc. ceased uranium chemical processing.

Rhenium was discovered in 1925 as a component of copper porphyry ore but was not processed at the Shattuck site until 1963.[58] At the time, only two other organizations produced any of this metal. During the next decade and a half, site activities focused on the roasting of molybdenite concentrates and produced rhenium as a byproduct of those activities.[59] During the 1960s and 1970s annual world rhenium production amounted to only several thousand pounds during any particular year. This production was sustained by a small number of specialty metal manufacturers in the U.S. and included production from the Shattuck site. During the 1970s, about 75 percent of the production in any year went into the production of bimetallic platinum-rhenium catalysts used in the refining of unleaded high-octane gasoline. The remaining production (about 25 percent annually) of domestic consumption was associated with high-temperature thermocouples, electronic devices, x-ray tubes and targets, electrical contacts, vacuum tube and flashbulb filaments, heating elements, metallic coatings, and electromagnets. During the 1970s, rhenium was evaluated as an alloying agent with nickel for use in jet engine turbine blades.[60] The research was successful and resulted in an expansion of the uses for rhenium during the late 1970s and early 1980s.

In the early 1980s the international molybdenum and rhenium markets paralleled the market decline for uranium and began to suffer from a combination of several trends. Supplies of molybdenum increased as it became an economical by-product of primary copper production in many parts of the world. Simultaneously, demand for molybdenum declined along with declining domestic steel production. The supply of rhenium, which is exclusively associated with the refining of molybdenum ores, also increased dramatically, driving prices and profits down. As a consequence of the market collapse, the production of rhenium and molybdenum became uneconomical at the site and all processing operations for these chemicals ceased by 1984.

When all active mineral processing operations at the Shattuck site ceased in April, 1984 all buildings except Building No. 3 were vacated. Building No. 3 remained occupied for administrative purposes and very limited reagent chemical processing until June, 1986 when this limited processing was also discontinued. Building No. 3 remained the only occupied building until November, 1992 when Buildings No. 1, 3 and 4 were demolished as part of the EPA Superfund remediation of the site. The remaining buildings, Buildings No. 2, 5 and 6, and any remaining structures on site will be demolished as part of the Superfund remediation action in mid-1993.



LOCATION MAP

NORTH

FEET

0 1000 2000 4000 5000 6000

METERS

0 250 500 750 1000 2000

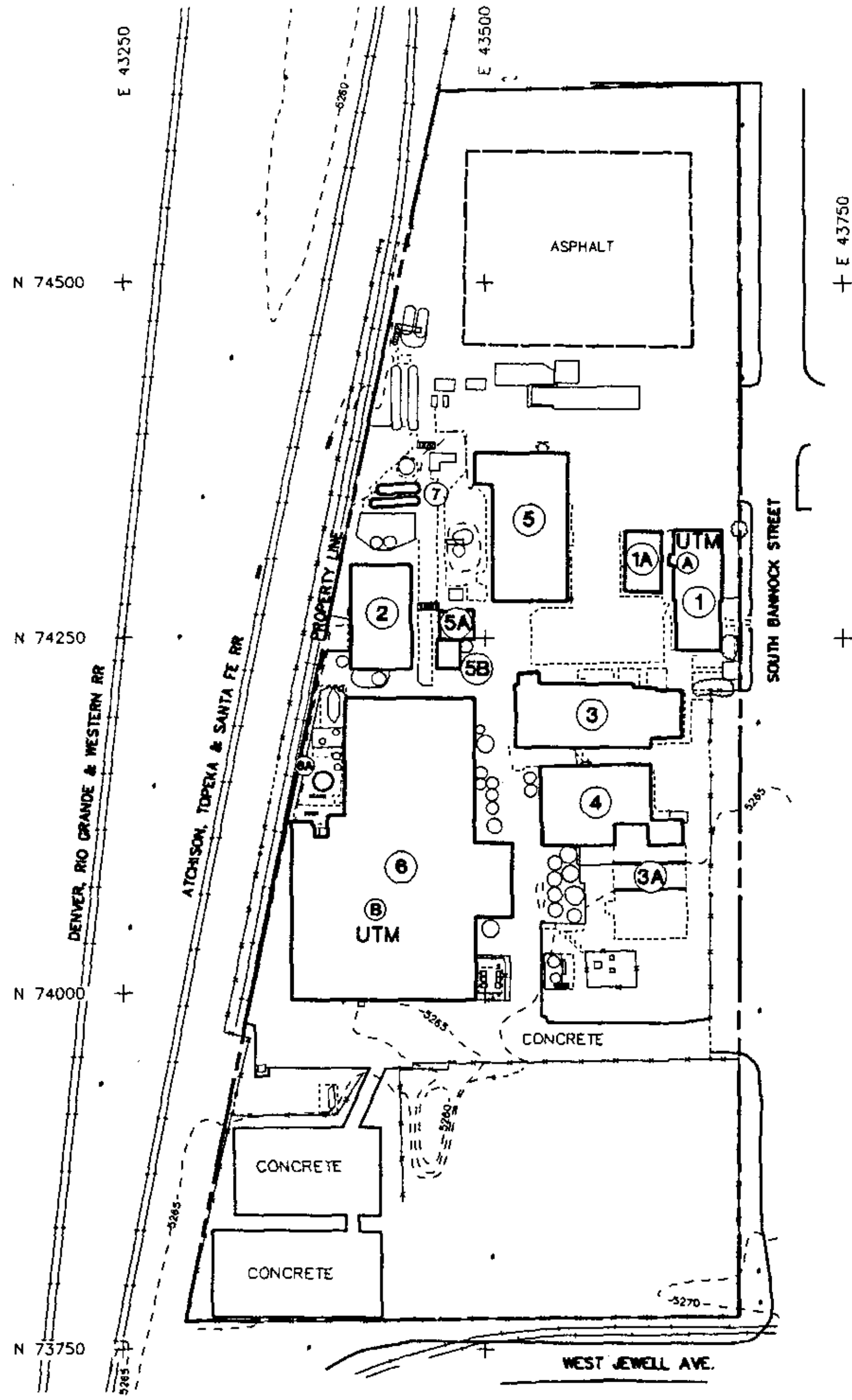
REFERENCES

1. USGS 7.5-MIN TOPOGRAPHIC QUADRANGLE ENGLEWOOD, COLORADO DATED 1965, PHOTOREVISED 1980 SCALE 1:24000.
2. USGS 7.5-MIN TOPOGRAPHIC QUADRANGLE FORT LOGAN, COLORADO DATED 1965, PHOTOREVISED 1980 SCALE 1:24000.
3. SE 1/4, SW 1/4, SECTION 22, T.4S., R.68W.

Part III. Architectural Information

Clustered at the center of the Shattuck site are six predominantly one-story industrial buildings; five ammonia storage tanks, and a number of smaller outbuildings, sheds and liquid storage tanks. Building No. 1, the main office and laboratory building, is located on the east-central portion of the property. Building No. 1's entry is located 15 feet off of South Bannock Street. Other building entries face one another and share large concrete-paved "courts" which suggest the industrial nature of the site and its accommodation to trucks, its major source of shipping despite the close proximity of rail lines.

The buildings are connected to each other by a series of above-grade steam lines and are linked to the many storage tanks by a network of above-grade pipes. At the north and south ends of the site are open dirt yards used for remote storage.



LEGEND

1 BUILDING NO. 1
1A MODULAR LABORATORIES
2 BUILDING NO. 2
3 BUILDING NO. 3
3A SECURITY WALLS
4 BUILDING NO. 4
5 BUILDING NO. 5
5A PIPE STORAGE
5B DEIONIZER SYSTEM
6 BUILDING NO. 6
6A STACK
7 AMMONIA STORAGE TANKS

BANNOCK STREET SITE UTM's
(A)-13 : 500880 E. 4392435 N
(B)-13 : 500820 E. 4392400 N

SITE PLAN

NORTH

FEET
0 30 60 90 120 240 300 360

METERS
0 10 20 30 40 50 100

Part IV. Endnotes

1. Mullen, John C., 1992, "Historical Building Inventory Records; The S. W. Shattuck Chemical Company, Inc., Bannock Street Site, Denver, Colorado," Prepared for U.S. Environmental Protection Agency, Region VIII, hereafter cited: Mullen, "Inventory."

2. Hill, David R., 1984, Colorado Urbanization and Planning Context, "Denver's Rail/Streetcar Period 1870-1920: Rail/Industrial/Warehousing," Colorado Historical Society.

3. Certified copy of map derived from Sanborn field surveys conducted in 1893.

4. Deed Book 1247, page 579, City and County of Denver.

S. Certified copy of map derived from Sanborn field surveys conducted in 1903.

6. Mullen, "Inventory," Building No. 3.

7. Deed Book 2330, page 150, City and County of Denver.

8. Deed Book 2399, page 5S0, City and County of Denver.

9. Articles of Incorporation dated August 24, 1916, Colorado Secretary of State.

10. Articles of Incorporation for the S. W. Shattuck Chemical Company dated March 25, 1918.

11. Final Letter Report, The Denver Radium - S. W. Shattuck Chemical Company Potential Responsible Party Search, USEPA Contract No. 68-01-7331, CDM Work Assignment No. T3-095, page 3.

12. Deed Book 3481, page 503, City and County of Denver.

13. Articles of Incorporation for York Ferro-Alloys Company dated May 31, 1919, Pennsylvania Secretary of the Commonwealth.

14. Mineral Resources, U. S. Geological Survey, 1916, 1919, 1923, pages 807, 728 and 249 respectively.

15. Bruyn, Kathleen, 1955, Uranium Country, University of Colorado Press, page 98.

16. Annual Report of Mining Company dated 1922, Colorado Secretary of State.

17. Articles of Incorporation for York Mining Company dated October 6, 1919, Colorado Secretary of State.

18. Notice of Dissolution for the York Mining Company dated February 2, 1923, Colorado Secretary of State.

19. Deed Book 2399, page 550, City and County of Denver.

20. Certified copy of map derived from Sanborn field surveys conducted in 1929.

21. Deed Book 579B, page 24, City and County of Denver.

22. Certified copy of map derived from Sanborn field surveys conducted in 1950.

23. Construction Permits No. 045550 dated October 20, 1955, No. 0542B4 dated December 29, 1955, and No. 000734 dated January 6, 1956, that were issued to various contractors by the City and County of Denver.

24. See: Fell, James E., Jr. 1979, Ores to Metals, The Rocky Mountain Smelting Industry, University of Nebraska Press; and Scamehorn, H. Lee, 1976, Pioneer Steelmaker in the West, Pruett Publishing Co.

25. See: Mullen, "Inventory."

26. Landa, Edward R., 1987 Buried Treasure to Buried Waste: The Rise and Fall of the Radium Industry, Colorado School of Mines Quarterly, 82, No. 2, pages 1-2, hereafter cited: Landa, Buried.

27. Landa, Buried, pages 5-6.

28. Landa, Buried, pages 7-10; and Husband, Michael B., 1982, "History's Greatest Mineral Hunt: The Uranium Boom on the Colorado Plateau," Journal of the West, page 1B; hereafter cited: Husband, "Greatest."

29. Landa, Buried, page 19.

30. Landa, Buried, pages 53-61; Parsons, Charles L., Moore, R.B., Lind, S.C., and Schaefer, O.C. Extraction and Recovery of Radium, Uranium, and Vanadium from Carnotite, 1915, U.S. Bureau of Mines, Bulletin 104, note that the Parsons volume has detailed descriptions and flow charts of the refining processes as practiced during the 1910s; and Rocky Mountain News, 10 March 1979, page 6.

31. Landa, Buried, pages 26-27.

32. Landa, Buried, pages 42-44; and Clark, Tom, May 1979, "Radium: The Rocky Mountain Horror Show," Rocky Mountain Magazine, pages 2B-30, hereafter cited: Clark, "Radium."

33. Building Permit No. 2604 dated October 15, 1934 and issued to The S. W. Shattuck Chemical Company for a frame and transite radium plant, City and County of Denver.

34. Minerals Yearbook, 1935, U. S. Bureau of Mines, page 557.

35. Minerals Yearbook, 1934, U. S. Bureau of Mines, page 497.

36. Minerals Yearbook, 1936, U. S. Bureau of Mines, page 503.

37. Inspector's Report for the Upper-Lower-Middle Mines of North Continent Mines, Inc. dated May 13, 1937, Colorado Bureau of Mines.

38. Inspector's Report of North Continent Mines, Inc. operations dated October 1, 1938, June 6, 1939, June 5, 1940, October 10, 1941, August 4, 1942, June 15, 1943, July 11, 1944, and August 4, 1944, Colorado Bureau of Mines.

39. Landa, Buried, Page 32-36.

40. Minerals Yearbook, 1941, U. S. Bureau of Mines, pages 802-803.

41. Ibid., p. 802.

42. Minerals Yearbook, 1942, U. S. Bureau of Mines, pages 826 and 678.

43. Minerals Yearbook, 1949, U. S. Bureau of Mines, page 1,250.

44. Pratt, Joseph Hyde, 1900, 1901, Minerals Yearbook, U.S. Bureau of Mines, 1900, page 259, 1901, pages 265-268.

45. Hess, Frank L. 1919, Minerals Yearbook, U.S. Bureau of Mines, pages 713-714.

46. Minerals Yearbook, 1941, U. S. Bureau of Mines, pages 802-803.

47. Anonymous, 1930, Minerals Yearbook, U.S. Bureau of Mines, pages 277-280.

48. Minerals Yearbook, 1958, U. S. Bureau of Mines, page 1,106.

49. Kuklis, Andrew. 1972 Minerals Yearbook, U.S. Bureau of Mines, page 793.

50. Kuklis, Andrew, 1972, Minerals Yearbook, U. S. Bureau of Mines, pages 793-397; and Blossom, John W., 1983; Minerals Yearbook, U. S. Bureau of Mines, pages 623-625.

51. Husband, "Greatest," pages 19-20.

52. Landa, Buried, page 50, and Building Permits No. 4183 dated July 15, 1924 (for a "framed storage shed"), No. 7452 dated November 13, 1924 (for an "iron garage on alley"), and No. 4937 dated July 16, 1925 (for an "iron storage area") were issued to the S. W. Shattuck Chemical Company, Denver Public Library.

53. Certified copy of map derived from Sanborn field surveys conducted in 1929.

54. See: Husband, "Greatest," and Bruyn, Country, and Taylor, Raymond W. and Taylor, Samuel W., 1970, Uranium Fever or No Talk Under $1 Million, The Macmillan Company.

55. Source Materials License No. R-104 dated March 18, 1955 issued by the U. S. Atomic Energy Commission to The S. W. Shattuck Chemical Company with an expiration date of April 1956. This license was received each year, until it was reissued in 1961 as SMB-479 in December 1961.

56. Source Materials License No. SMB-479 dated March 30, 1962, March 30, 1965, and March 9, 1971 issued by the U. S. Atomic Energy Commission to the S. W. Shattuck Chemical Company.

57. Clark, see "Radium," and Rocky Mountain News, 10 March 1979, page 6.

58. Minerals Yearbook, 1963, U. S. Bureau of Mines, page 1,278.

59. Minerals Yearbook, 1964, U. S. Bureau of Mines, page 1,233;
Minerals Yearbook, 1965, U. S. Bureau of Mines, page 779;
Minerals Yearbook, 1967, U. S. Bureau of Mines, page 123;
Minerals Yearbook, 1968, U. S. Bureau of Mines, page 1,193;
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Minerals Yearbook, 1971, U. S. Bureau of Mines, page 1,023;
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Minerals Yearbook, 1982, U. S. Bureau of Mines, page 715;
Minerals Yearbook, 1983, U. S. Bureau of Mines, page 966.

60. Minerals Yearbook, 1975, U. S. Bureau of Mines, page 1,223.